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ABSTRACT

This study examines the effects of readiness level and learning modality emphasis on the form discrimination performance of kindergarten children on training and transfer tasks. Forty-eight male and 48 female kindergarten children between the ages of 5.5 and 6.5 years participated in the study. The children were randomly selected from a group of 109 children with high scores on the Metropolitan Readiness Test and from a group of 50 children with low scores. Four letter-like designs were presented to the subjects in haptic, visual, visual-haptic, and visual-verbal conditions. In the pre-training sessions, the distinctive features of these designs were described using one of the four modalities. In the training sessions, subjects were asked to identify one of the designs from a set of two. In the transfer sessions, the subjects were asked to identify the designs which were embedded in noise backgrounds. Results were analyzed through a three-way (modality by readiness by sex) analysis of variance. The results suggest that readiness level has some bearing on learning modality preference. Some sex differences in learning modality preference were also found. (BD)

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Interaction Effects of Readiness Level and Type of Form Discrimination Emphasis on Training and Transfer in Young Children

Paper presented at

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April 1979

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INTRODUCTION

The Distinctive Features Hypothesis, as explained by Gibson (1965) states a psychological learning position which describes how children acquire letter discrimination ability. The hypothesis suggests that children learn to detect and attend to those features of letters which aid them in distinguishing one symbol from another while also learning to ignore the irrelevant features not needed for letter identification. Subsequently, Gibson and Levin (1975) consider the ability to define sets of letter symbols transferable to reading.

From a child developmental position, two additional attributes must be considered: 1) cognitive readiness level and 2) dominant learning modality. Piaget & Inhelder (1956) note aspects of the first issue, cognitive levels. They show that the kindergarten child is in the preoperational stage of cognitive development. The early phase of this stage (ages 2-4) highlights the child's new ability to demonstrate symbolic thought such as that used in language and dramatic play while continuing to develop sensorimotor schemes. During the later phase of preoperational development (ages 5-7), the child begins to acquire the ability for analyzing many more abstract symbols--letters being among them. While the four-to-five year old is cognitively ready to learn distinctions between letters, transferring this knowledge is still a problem as his thought is characterized by the tendency to confuse unrelated concepts (Ginsburg & Opper, 1969).

It appears that Piagetian theory suggests that children in the early preoperational phase (lower readiness level for learning letter symbols) depend more on sensorimotor input than do children in the later preoperational phase (high readiness level for learning such symbols). Since kindergarten children are in a transitional stage between the earlier and later phases of preoperational development, it would appear that this age group represents both children with high and low readiness level skill for learning letter symbols and related concepts. Under this assumption, it becomes important to determine the dominant learning modality of children at different readiness levels.

Silver and Rollins (1973) use the Distinctive Features Hypothesis to address the developmental issue of dominant learning modality. Using letter-like form stimuli embedded in noise backgrounds, they investigated the effects of visual, verbal and a combination of visual and verbal modality learning with kindergarten children. The results indicated that the visual modality alone was better utilized in learning and transferring the stimuli differentiation task. Two issues in developmental theory arise in relation to the Silver and Rollins' study. First, there was no attempt to identify the sample in terms of the high and low cognitive readiness level. Second, the haptic learning modality, which is related to the sensorimotor experience, was not included among the experimental variables.

A number of researchers have investigated whether the visual modality is dominant over the haptic modality (Schneiderman 1971; Pick, Klein & Pick 1966; Millar 1971; and Krauthamer 1968). With research designs ranging from intra- and inter-modal training and transfer tasks, successive and simultaneous stimuli presentations, and training with and without using trials to criterion, the visual modality was shown to be dominant over the haptic modality in facilitating form discrimination learning. Significant age effects did occur favoring five- to six-year-olds over four-year-olds.

When Silver and Rollins analyzed the performance of their sample across sex, they found that males discriminate letter-like forms far better than females. Generally, males are found to be superior on analytic reasoning while females excel in verbal tasks and tasks which involve the discrimination of two-dimensional graphic forms (Satterly, 1968; Sapir, 1966; Waetjen & Grambs, 1963; Dick, 1976). In a study comparing age and sex on the acquisition of form discrimination ability, Tyler & Hardy (1977) found that female performance begins to excel that of male performance on a two-dimensional discrimination task between ages 4.0 and 4.5.

In summary, form discrimination learning appears to be a function of several variables operating together. As noted in the studies cited, some of these variables include readiness level; type of modality used in a learning situation; age and sex differences; and children's performance when they are presented with an initial form discrimination learning or transfer task. The purpose of this study is to test whether kindergarten children's readiness levels interact with visual, visual-verbal, haptic, and visual-haptic modality emphasis learning when measured on both training and transfer form discrimination criteria. A secondary purpose is to examine whether sex differences exist with respect to children's ability to learn form discrimination when readiness and type of learning modality are considered. The hypotheses are as follows:

Hypothesis 1: Low readiness children learn form discrimination more effectively under the haptic and visual-haptic pretraining modalities compared to high readiness children who learn form discrimination more effectively under the visual and visual-verbal pretraining modalities.

Hypothesis 2: Among high readiness children, the visual and visual-verbal pretraining modality groups show a greater performance than the haptic and visual-haptic pretraining modality group.

Hypothesis 3: Among low readiness children, the haptic and visual-haptic pretraining modality groups show a greater performance than the visual and visual-verbal pretraining modality groups.

In addition to the hypotheses, two questions are posed to determine if there are any sex differences associated with form discrimination learning:

1. Is there an interaction between sex and type of pretraining modality?
2. Is there an interaction between sex and readiness level?

METHOD

Subjects

A group of 96 kindergarten children (48 males and 48 females) between the ages of 5.5 and 6.5, from two different schools in Frederick County, Maryland, were randomly selected from a total pool of 109 high scorers (7th, 8th, and 9th stanines) and a total pool of 50 low scorers (2nd, 3rd, and 4th stanines) on the Metropolitan Readiness Test (MRT), Form A. None of the children in this sample scored in the 1st stanine. The MRT was administered to the subjects by their teacher during the late spring of their kindergarten year.

In general, Frederick County is considered a rural area. The selected two schools, however, were somewhat different with respect to their student population. School Number 1 was located in a new housing development. The children were predominantly White and very few of them had stanine scores below 6. According to the principal, most of the children were from middle class, white collar and professional families.

School Number 2 was located in the downtown area of the City of Frederick. The population of this school was more equally represented by both Black and White race groups. Many of the children had stanine scores of 7 and below and were from families of lower to middle income levels.

Description of Stimuli Used in Pretraining, Training, and Transfer

Pretraining Stimuli. The four visual, haptic, and verbal pretraining form stimuli were labeled YUD, HEY, TUF, and MEM. They were drawn on 3 inch by 5 inch white cards in black ink with red ink used

to emphasize five different aspects of the form and measured 1 inch by 1 inch. Five statements accompanied the verbal pretraining stimuli. The four haptic pretraining forms were cut from plywood and measured 4 inches. During the visual-haptic and visual-verbal pretraining conditions, the stimuli described above were used in combination. The instructions for these conditions are shown in Figure 1.

Training Stimuli. The training stimuli for all subjects in all conditions were the same. Training stimuli consisted of a total of 12 forms which resulted from combining the four pretraining stimuli with the three training backgrounds. Each 1 inch by 1 inch pretraining form was drawn in black ink on a 3 inch by 5 inch white card. The background was also drawn in black ink, and when it was combined with the pretraining stimuli, resulted in a 2 inch by 2 inch stimulus. These stimuli were originally designed by Silver and Rollins (1973) and are shown in Figure 2.

Transfer Stimuli. The transfer stimuli for all subjects in all conditions were the same. The transfer stimuli consisted of 12 forms which resulted from adding the four pretraining stimuli (YUD, HEY, TUF, and MEM) to three new noise backgrounds. Each 1 inch by 1 inch pretraining form was drawn in black ink on a 3 inch by 5 inch white card. The background was also drawn in black ink, and when combined with the pretraining stimuli, resulted in a 2 inch by 2 inch transfer stimulus. Another set of 12 transfer distractor forms consisted of the three familiar training noise backgrounds and the three transfer noise backgrounds. Each of these backgrounds was combined with one of a possible two unfamiliar letter-like forms. This set of transfer distractors consisted of a set of 12 forms. They were drawn exactly as described above. The 12 transfer forms and the 12 transfer distractor forms are shown in Figure 2.

Design of the Experiment

A 4 (emphasis) x 2 (sex) x 2 (readiness level) fixed factorial design was used. The independent variables were emphasis (visual,

haptic, visual-haptic, and visual-verbal), sex (male and female), and readiness (high scores and low scores). The dependent variable on the training task was the total number of correct responses on trials to criterion (9 out of 27 correct responses). The criterion was chosen because it was found to be successful by Silver and Rollins as well as by the author in some pilot work. Each simultaneous presentation of two stimuli requiring a response constituted one trial to criterion. Trials were given until the subject made 9 out of 27 correct responses. The dependent variable on the transfer task was the total number of correct responses. A total of 18 transfer trials was given.

Procedure

The procedure followed during the pretraining, training, and transfer phases is described below:

Pretraining. The purpose of the pretraining was to point out the distinctive features of the forms using either visual, haptic, verbal (auditory), of combinations or these modes of presentation. One pair of pretraining stimuli labeled either YUD-HEY, YUD-TUF, YUD-MEM, HEY-TUF, HEY-MEM, or MEM-TUF were randomly assigned to each of the six subjects in cell 1 of the 16 cell matrix (4x2x2). This randomization pattern was counterbalanced across the other 15 cells for the remaining 90 subjects.

During visual and visual-verbal emphasis pretraining, one stimulus was placed on the table in front of the subject for five pretraining trials and then a second stimulus was placed in front of the subject for five more pretraining trials. Each trial was five seconds in length. Stimuli were always displayed in a horizontal (left-right) scan position in front of one subject. As part of all subjects' pretraining experience, they learned to associate a label with the variants of the two standard forms even though this label was not required as a response. Each subject in the visual emphasis condition was simply shown the emphasized letter-like stimuli (see Figure 1). The subjects in the visual-verbal emphasis

condition were shown the letter-like stimuli while being read each of five sentences which defined specific form attributes (see Figure 1).

During haptic and visual-haptic emphasis pretraining, the subjects were presented with a pair of three-dimensional, letter-like forms made of plywood. The subject felt the first standard form with his/her hands on five continuous occasions for 5 seconds each and then he/she felt the second standard form in the same manner. The subject did this by placing his/her hands inside the green, cloth, drawstring bag and actively touching the form while being unable to view it. The subject was given the label for each stimulus at the time of each trial. In the haptic emphasis condition, subjects were limited to just touching the form. In the visual-haptic emphasis condition, subjects were shown pictures of the pair of standard forms as he/she actively touched the matching plywood form in the cloth bag.

Training. On each training trial, two stimuli were placed beside each other in front of the subject. The subject was given one of the two labels he learned and asked to find the letter-like form it identified. One member of the pair of stimuli was always a variant of a single standard form which the subject was pretrained to recognize. There were three variants for each form presented during pretraining. The other member of the pair was randomly selected from the remaining nine stimuli. The experimenter named the stimulus class and the subject responded by pointing to the correct example. The correct stimulus was randomized with respect to left-right position. The subject was trained to a total criterion of 9 out of 27 correct responses on the pair of standard forms he had learned to recognize during the pretraining session. During training, a correction procedure was used by taking the child's hand and putting it on the correct stimuli whenever the subject made an error.

Transfer. During each trial on the transfer task, a series of four stimuli were spread out on the table in front of the subject.

Again, the subject was given one of two labels he had learned during pretraining and was asked to find the designated stimulus within the stimuli presented to him on each of 18 trials. No reinforcement was given. Each of the stimuli displays consisted of the two forms embedded in unfamiliar transfer backgrounds (set of 12), along with two new distractor letter-like forms embedded in familiar training backgrounds and unfamiliar transfer backgrounds (set of 12). Therefore, the array of four transfer stimuli consisted of two distractor forms with a familiar and unfamiliar background, a designated transfer stimulus, and one other transfer stimulus on each trial. The dependent variable was the total number of correctly identified forms.

Testing Conditions

During the administration of the pretraining, training, and transfer phases of this experiment, each subject was interviewed individually for a maximum of 20 minutes in a room apart from the regular classroom. These three phases followed in successive order. One two-minute break was given after the training phase. During this break the child engaged in some stretching exercises with the experimenter. Only one interview was scheduled with each subject. This interview took place within two to three weeks after the MRT had been administered.

RESULTS

The first section of the results is entitled "Initial Analysis" and presents the findings of the original 4x2x2 (modality x readiness x sex) analysis of variance. This analysis was performed to investigate the questions on the relationship between sex and form discrimination learning and to obtain the appropriate mean square error term used in making the comparisons relevant to Hypotheses 1, 2, and 3. The second section entitled "Primary Analysis" presents the findings regarding Hypotheses 1, 2, and 3.

Initial Analysis

The means and standard deviations for the entire population across the four levels of modality, two levels of readiness, and two levels of sex for both training and transfer are presented in Table 1.

An examination of Table 1 shows that haptic experience required more trials to criterion (highest scores) than visual-haptic experience which required the least trials to criterion (lowest scores) for levels of modality during the acquisition of training criterion. (The higher the score on the training trials to criterion the more ineffective was the subject's performance on the task.) Along the transfer criterion, however, the mean performance for the haptic pretraining modality shows scores were lower than they were for the other three pretraining learning modalities. (The higher the score on the transfer task the more effective was the subject's performance.)

The means and standard deviations for the two readiness levels show that low readiness children had higher scores (more ineffective) on trials to criterion than the high readiness children on the training criterion. On the transfer task, a higher mean score (more effective) is shown for the high readiness group than for the low readiness group. The means and standard deviations along the sex variable show that females required more trials to criterion (higher scores) than males (lower scores) on the training task, and males had higher scores (more effective) than females on the transfer task.

Table 2 presents the marginal means and standard deviations when the relationship between readiness by sex and modality by sex are examined. It can be seen that high readiness males require more trials to criterion on the training task than high readiness females, while low readiness females require more trials to criterion on training than low readiness males. Both high and low readiness males score higher on the transfer criterion than both high and low readiness females. When the modality by sex means are examined, it becomes apparent that males require less trials to criterion on the training task than females whenever visual input is given.

Table 3 shows the results of the 4x2x2 analysis of variance for the training criterion and addresses the two questions posed regarding the effect of sex on form discrimination learning. Table 3 indicates that there is a significant interaction between sex and modality for training, $F = (3,80) = 2.974$, $p < .05$. There was no significant interaction effect for readiness by sex. Figure 3 provides a graphic display of the sex by modality interaction.

Table 4 presents the results of the 4x2x2 analysis of variance for the transfer criterion which addresses the two questions posed regarding the effect of sex on form discrimination learning for the transfer task. As can be seen, neither the modality by sex nor the readiness by sex interactions are significant.

Primary Analysis

The analysis relevant to Hypothesis 1 required collapsing the visual-verbal and visual modality conditions for both high and low readiness children across the training and transfer criteria. The cell means for both training and transfer criteria are shown in Table 5.

To test the relationship between modality and readiness, a 2x2x2 (modality x readiness x sex) analysis of variance was run on both the training and transfer criteria. The results of this analysis for training are shown in Table 6. The mean square error of .542 from the initial 4x2x2 analysis of variance was used to obtain the F value for the training criterion. As can be seen in Table 6, there is a significant interaction between modality by readiness, $F (1,80) = 4.19$, $p < .05$. The direction of the modality by readiness interaction is consistent with that which was predicted. Figure 4 gives a graphic display of the readiness by modality interaction for training.

Table 7 presents the results of the 2x2x2 analysis for the modality by readiness interaction under the transfer condition. The mean square error of 27.439 from the initial 4x2x2 analysis of variance was used to test the interaction effect. The modality by readiness effect was not significant.

Hypothesis 2 was tested by examining simple main effects. Table 8 presents the means and standard deviations for training and transfer criteria for high readiness children broken down by modality when modality is collapsed by combining haptic and visual-haptic scores and visual and visual-verbal scores.

To test the simple main effects, a one-way analysis of variance with two levels of modality (visual and visual-verbal and haptic and visual-haptic) was performed on the training and transfer criteria for high readiness children. The mean square error of .542 was taken from the initial 4x2x2 analysis of variance. Table 9 shows the results of this analysis. A significant modality effect was shown for high readiness children on the training criterion, F (1,80) = 5.09, $p < .05$.

Table 10 shows a similar significant modality effect for high readiness children on the transfer criterion. The mean square error of 27.439 was taken from the initial 4x2x2 analysis of variance. A significant effect was shown for high readiness children on the transfer criterion, F (1,80) = 5.49, $p < .05$.

Hypothesis 3 was also tested by examining simple main effects. Table 11 presents the mean and standard deviations for training and transfer criterion for low readiness children broken down by modality when modality is collapsed by combining haptic and visual-haptic scores and by combining visual and visual-verbal scores.

Table 12 presents the summary for the one-way analysis of variance for the training criterion. The mean square error of .542 was taken from the initial 4x2x2 analysis of variance. As can be seen, no significant modality effect exists for low readiness children on the training criterion.

Table 13 presents the summary for the one-way analysis of variance for the transfer criterion. The mean square error of 27.439 was taken from the initial 4x2x2 analysis of variance. As shown, there was also no significant modality effect for low readiness children on the transfer criterion.

DISCUSSION

The findings establish some basis for accepting the notion that young children's readiness level has a bearing on their learning modality preference. From an examination of Hypothesis 1, it appears that there is an interaction between readiness and modality on the form discrimination training criterion. As shown in Figure 4, high readiness children require less trials to criterion when pretrained on the visual and visual-verbal modality and low readiness children require less trials to criterion when pretrained on the haptic and visual-haptic modality.

In part, Piagetian theory might be considered when interpreting the interaction along this dimension. This theory suggests that children at earlier stages of cognitive development depend more on sensorimotor input than do children at later stages. In that low readiness children demonstrated greater reliance on sensorimotor activity may imply that they are still in the early phase (egocentrism) of pre-operational development, rather than at the later phase (intuitive) of this stage. Thus, the low readiness child's ability to utilize visual cues in defining distinctive features may not be well developed.

When high and low readiness level is analyzed separately, as described by Hypotheses 2 and 3, a similar pattern is shown for high readiness children. It also appears that high readiness children learn to discriminate form more effectively and transfer this ability more effectively when they are pretrained on visual and visual-verbal stimuli while low readiness children appear to have no consistent way of assimilating form discrimination. For example, low readiness children tend to get slightly better scores on the haptic and visual-haptic training stimuli than do high readiness children, but low readiness children tend to rely as much as the high readiness children on visual and visual-verbal modality experience on the transfer stimuli. This may reflect a lack of general

strategy in low readiness children for assimilating form discrimination material regardless of the sensory learning modality. Therefore, it appears that the facility for mastering form discrimination on the selected training and transfer tasks depends on the readiness level of the child and the successful use of visual and visual-verbal learning modalities.

These results are partially consistent with the findings of Silver and Rollins (1973). Referencing the Distinctive Feature Hypothesis, their investigation established that visual emphasis pretraining was the most successful learning modality for their sample of kindergarten children on both training and transfer tasks. Silver and Rollins did not, however, assess the readiness level of their sample. The findings in the present study showing that high readiness children were able to perform on the training and transfer tasks significantly better than low readiness children might possibly indicate that the ability to handle learning of form discrimination on training and transfer tasks may occur simultaneously. This ability may differentiate the high and low readiness child on form discrimination prereading skills.

The nature of the sample population in the present study suggests caution be used in interpreting the results associated with readiness. That is, a large proportion of the high readiness children were members of School Number 1 and a large proportion of the low readiness children were members of School Number 2. This implies that the school environments were different as well as were many of the uncontrolled variables relating to the children such as socioeconomic level, living arrangement, and race. Therefore, systematic differences assigned to readiness may be confounded with school environment and other uncontrolled variables associated with the children.

Additionally, it is not known whether the teachers had different methods of administering the readiness instrument. For instance, it is unknown whether they viewed the instrument as a learning situation for the children or whether they considered the

administration of the instrument a formal examination session. These concerns present constraints to the intrepretation and generalizability of the results.

The findings also indicated some sex differences. The significant sex by modality interaction is depicted in Figure 3. It appears that on the training criterion males utilize visual and visual-verbal information more efficiently than females, while females are more effective in using haptic emphasis areas. This result is partially consistent with Silver and Rollins (1973) who found that males performed better on a form discrimination task than females. Silver and Rollins' explanation for this suggested that males have more analytic reasoning ability than females at the kindergarten level. This explanation may have some merit for interpreting the findings of the present study when Held's notion is considered (Dick, 1976).

Held suggests that there are two visual systems, one specialized for form perception and another one specialized for space perception. Held hypothesizes that males consistently perform better on spatial perception tasks and females perform better on form perception tasks. It may be that the embedded form discrimination training and transfer tasks represented a spatial or analytical reasoning problem rather than a two-dimensional form discrimination problem. If this is the case, then the males' greater performance may again point to their facility in understanding spatial tasks.

The findings of this investigation may have some interesting practical application. Teachers generally present conceptual materials visually and verbally. For the high readiness child this appears to be the optimal kind of classroom experience. The learning experience of the low readiness child may be facilitated slightly by haptic experiences, but according to the results of the training and transfer tasks, no specific, strong learning modality can be identified for the low readiness child.

Given that high readiness children show the most success on visual and visual-verbal emphasis learning, perhaps children who do do not succeed on visual and visual-verbal form discrimination tasks can be recognized as students who need additional pre-reading skill development and more time in which to assimilate the information.

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TUF

Feature	Visual	Haptic	Verbal
1. Vertical lines			A TUF has no lines that go up and down.
2. Diagonal lines			A TUF has two lines that lean to one side.
3. Straight and curved lines			A TUF has a curved line at the top.
4. Intersection			A TUF has two arrows which come together.
5. Symmetry			If you cut TUF in half, both pieces look the same.

MEM

1. Vertical lines			A MEM has no lines that go up and down.
2. Diagonal lines			A MEM has one line that leans on its side.
3. Straight and curved lines			A MEM has a straight line and two curved lines.
4. Intersection			A MEM does not have lines which come together.
5. Symmetry			If you cut a MEM in half, both pieces look different.

FIGURE 1: VISUAL, HAPTIC, AND VERBAL INFORMATION

VISUAL, HAPTIC, AND VERBAL INFORMATION

YUD

Feature	Visual	Haptic	Verbal
1. Vertical lines			A YUD has two lines that go up and down.
2. Diagonal lines			A YUD has two lines that lean to one side.
3. Straight and curved lines			A YUD has only straight lines.
4. Intersection			A YUD has an arrow and a straight line that come together.
5. Symmetry			If you cut a YUD in half both pieces look the same.

HEY

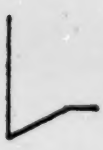
1. Vertical lines			A HEY has one line that goes up and down.
2. Diagonal lines			A HEY has a little line that leans to one side.
3. Straight and curved lines			A HEY has only straight lines.
4. Intersection			A HEY does not have lines which come together.
5. Symmetry			If you cut a HEY in half, both pieces look different.

FIGURE 1: (continued)

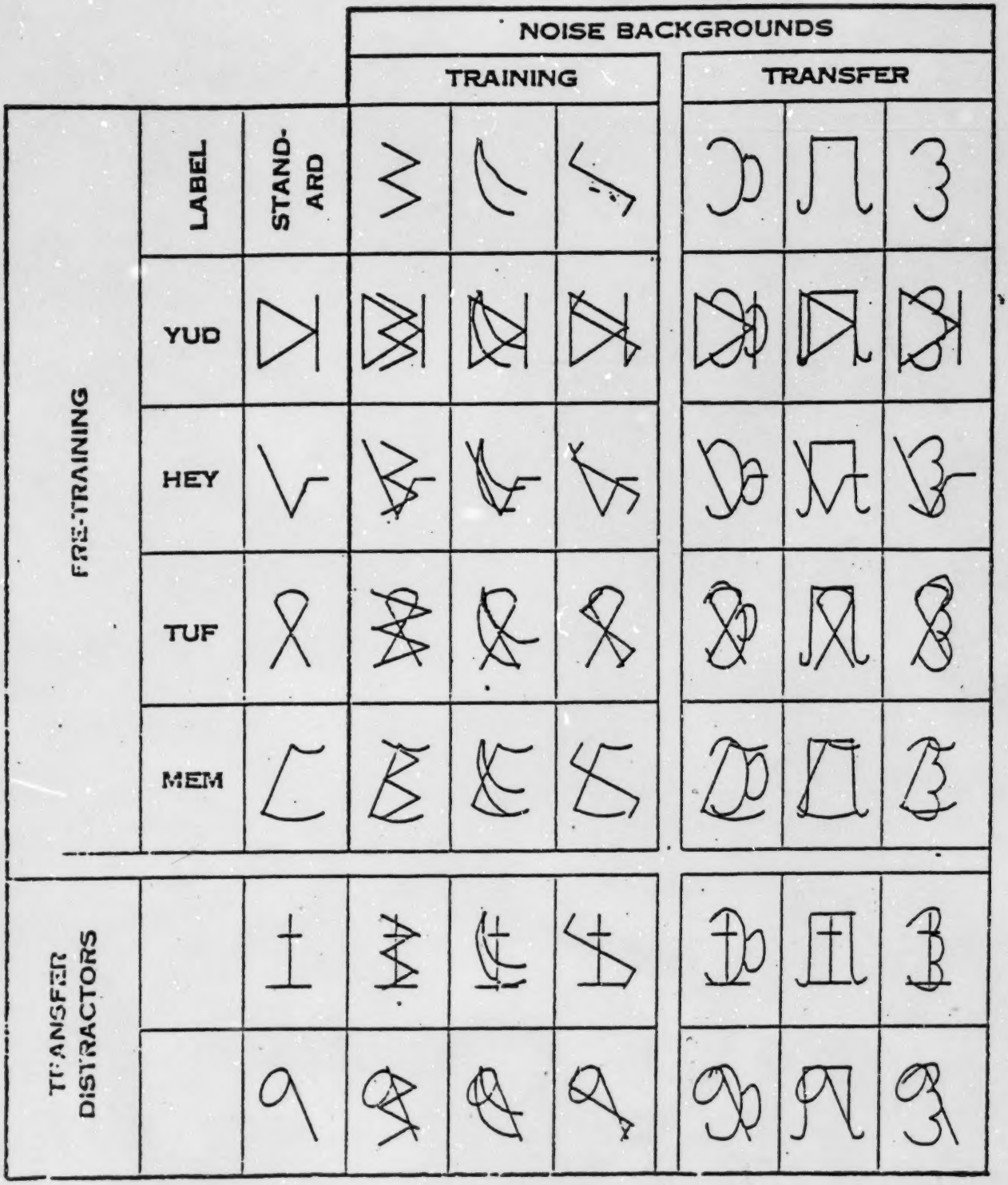


FIGURE 2: THE SIX STANDARD FORMS, SIX NOISE BACKGROUNDS, AND RESULTING VARIANTS

TABLE 1

MEANS AND STANDARD DEVLATIONS--MODALITY, READINESS AND SEX

Modality

	Training Criterion		Transfer Criterion	
	Means	S.D.	Means	S.D.
Visual	7.0384	.7957	12.6250	6.0059
Haptic	7.5646	.7861	7.7917	4.1909
Visual-Haptic	6.8313	.5704	12.1250	5.0330
Visual-Verbal	7.0132	.9101	12.5833	5.8899

Readiness

	Training Criterion		Transfer Criterion	
	Means	S.D.	Means	S.D.
High	7.0039	.7769	12.8958	5.3005
Low	7.2198	.8378	9.6667	5.5288

Sex

	Training Criterion		Transfer Criterion	
	Means	S.D.	Means	S.D.
Males	7.0309	.8014	11.7292	5.5033
Females	7.1928	.8208	10.8333	5.7698

TABLE 2

MEANS AND STANDARD DEVIATIONS—READINESS BY SEX AND MODALITY BY SEX

Readiness By Sex

	Training Criterion		Transfer Criterion	
	Means	S.D.	Means	S.D.
High Readiness				
Male	7.0611	.9057	13.4583	4.6902
Female	6.9467	.6375	12.3333	5.8952
Low Readiness				
Male	7.0007	.7002	10.0000	5.8010
Female	7.4390	.9186	9.3333	5.3460

Modality By Sex

	Training Criterion		Transfer Criterion	
	Means	S.D.	Means	S.D.
Males				
Visual	6.6853	.5564	12.6667	6.3723
Haptic	7.8088	.8565	9.1667	4.7450
Visual-Haptic	6.8248	.6613	10.9167	4.5017
Visual-Verbal	6.8047	.6091	14.1667	5.5405
Females				
Visual	7.3915	.8615	12.5833	5.9001
Haptic	7.3204	.6544	6.4167	3.1754
Visual-Haptic	6.8378	.4929	13.3333	5.4328
Visual-Verbal	7.2217	1.1252	11.0000	6.0302

TABLE 3

INITIAL ANALYSIS OF VARIANCE FOR TESTING EFFECTS OF THE TRAINING CRITERION

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability Less Than
Modality	7.172	3	2.391	4.410	.006
Readiness	1.118	1	1.118	2.063	.155
Sex	.629	1	.629	1.160	.285
Mod. X Readiness	2.482	3	.827	1.526	.214
Mod. X Sex	4.836	3	1.612	2.974	.037
Readiness X Sex	1.836	1	1.836	3.386	.069
Mod. X Readi X Sex	1.040	3	.347	.639	.592
Error Term	43.366	80	.542		
Total	62.479	95	.658		

TABLE 4

INITIAL ANALYSIS OF VARIANCE FOR TESTING EFFECTS OF THE TRANSFER CRITERION

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability Less Than
Modality	393.365	3	131.121	4.779	.004
Readiness	250.260	1	250.260	9.120	.003
Sex	19.260	1	19.260	.702	.405
Mod. X Readiness	19.865	3	6.622	.241	.867
Mod. X Sex	121.365	3	40.455	1.474	.228
Readiness X Sex	1.260	1	1.260	.046	.831
Mod. X Readi X Sex	6.865	3	2.288	.083	.969
Error Term	2195.157	80	27.439	1.973	
Total	3007.397	95	31.657		

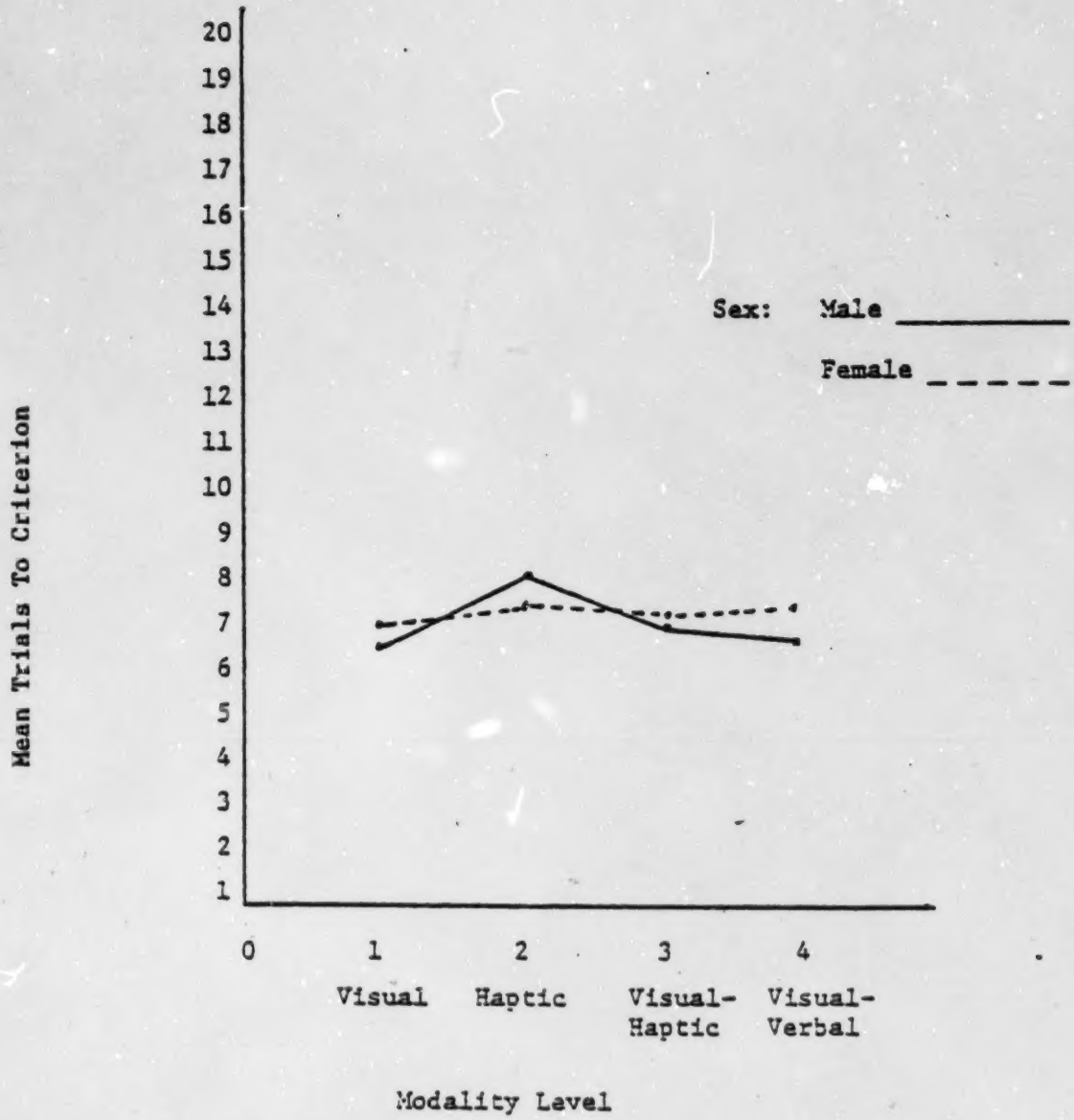


FIGURE 3: RELATIONSHIP BETWEEN MODALITY AND SEX FOR THE TRAINING CRITERION

TABLE 5

CELL MEANS FOR COLLAPSED 2 X 2 X 2 ANALYSIS OF VARIANCE FOR TRAINING AND TRANSFER CRITERIA

Modality	Readiness	Sex	Training Criterion Means	Transfer Criterion Means
Visual & Visual-Verbal	High	Male	6.6325	15.3335
Haptic & Visual-Haptic	High	Male	7.4897	11.5833
Visual & Visual-Verbal	High	Female	6.8955	14.0000
Haptic & Visual-Haptic	High	Female	6.9978	10.6667
Visual & Visual-Verbal	Low	Male	6.8578	11.5000
Haptic & Visual-Haptic	Low	Male	7.1439	8.5000
Visual & Visual-Verbal	Low	Female	7.7176	9.5834
Haptic & Visual-Haptic	Low	Female	7.1604	9.0834

TABLE 6

ANALYSIS OF VARIANCE COLLAPSED ACROSS MODALITY FOR TESTING EFFECTS OF MODALITY BY READINESS INTERACTION FOR TRAINING CRITERION USING THE MEAN SQUARE ERROR FROM INITIAL ANALYSIS

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability
Modality	.710	1	.710	1.31	>.05
Readiness	1.118	1	1.118	2.06	>.05
Sex	.629	1	.629	1.16	>.05
Mod. X Readiness	2.269	1	2.269	4.19	<.05
Modality X Sex	3.830	1	3.830	7.07	<.05
Readiness X Sex	1.836	1	1.836	3.39	>.05
Mod. X Readi X Sex	.012	1	.012	.02	>.05
Error Term	43.366	80	.542		
Total	53.770	87			

TABLE 7

ANALYSIS OF VARIANCE COLLAPSED ACROSS MODALITY FOR TESTING EFFECTS OF MODALITY BY READINESS INTERACTION FOR TRANSFER CRITERION USING THE MEAN SQUARE ERROR FROM INITIAL ANALYSIS

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability
Modality	168.010	1	168.010	6.123	<.05
Readiness	250.260	1	250.260	9.121	<.05
Sex	19.260	1	19.260	.702	>.05
Mod. X Readiness	19.260	1	19.260	.702	>.05
Modality X Sex	12.760	1	12.760	.465	>.05
Readiness X Sex	1.260	1	1.260	.045	>.05
Mod. X Readi X Sex	6.510	1	6.510	.237	>.05
Error Term	2195.157	80	27.439		
Total	2672.477	87			

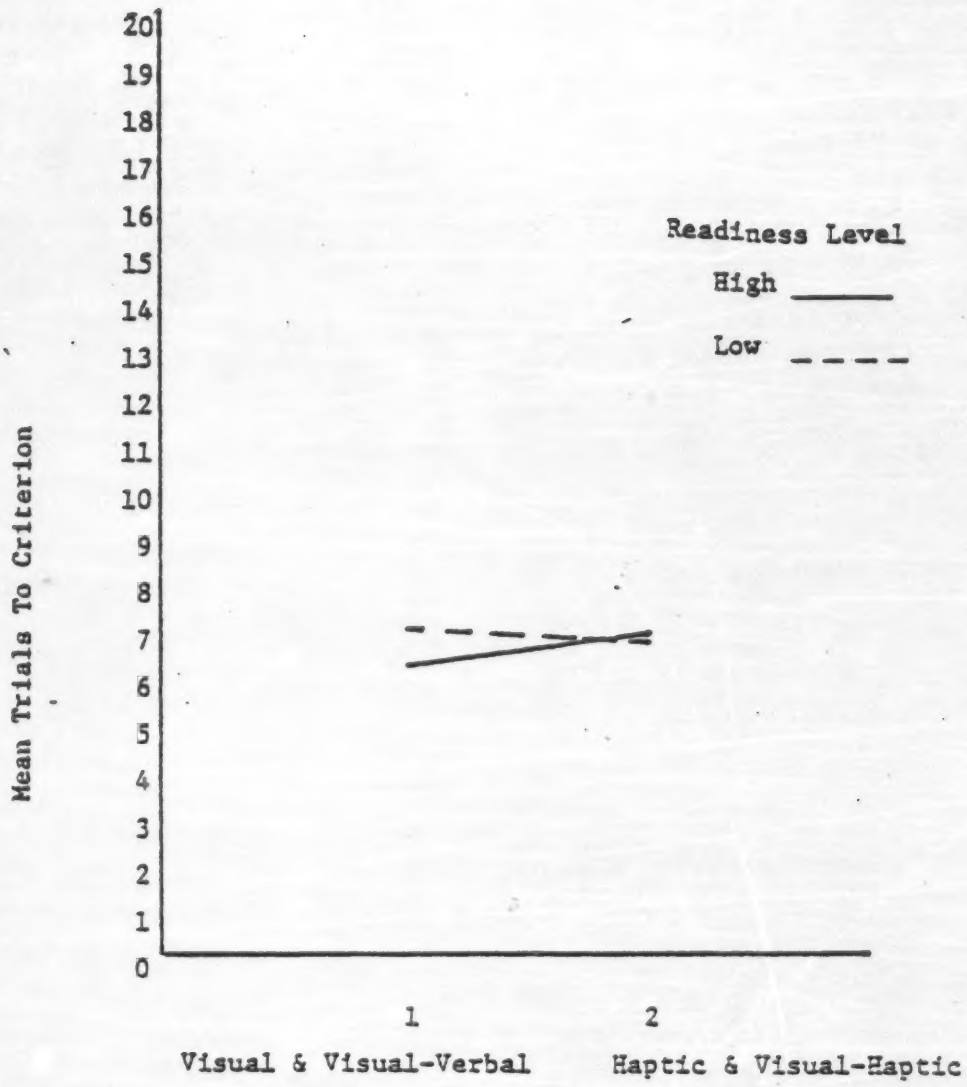


FIGURE 4: RELATIONSHIP BETWEEN READINESS LEVEL BY MODALITY LEVEL FOR TRAINING

TABLE 8

MEANS AND STANDARD DEVIATIONS - COLLAPSED LEVELS OF MODALITY BY HIGH READINESS FOR TRAINING AND TRANSFER CRITERIA

Modality by High Readiness

	Training Criterion		Transfer Criterion	
	Means	S.D.	Means	S.D.
Visual & Visual-Verbal	6.7640	.6398	14.6667	5.1132
Haptic & Visual-Haptic	7 2438	.8391	11.1250	4.9722

TABLE 9

ANALYSIS OF VARIANCE SUMMARY TABLE FOR EFFECTS TESTED AGAINST THE INITIAL ANALYSIS TO OBTAIN A SIMPLE MAIN EFFECT FOR MODALITY FOR TRAINING CRITERION FOR HIGH READINESS CHILDREN

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability Less Than
Modality	2.762	1	2.762	5.09	.05
Error Term	43.366	80	.542		
Total	46.128	81			

TABLE 10

ANALYSIS OF VARIANCE SUMMARY TABLE FOR EFFECTS TESTED AGAINST THE INITIAL ANALYSIS TO OBTAIN A SIMPLE MAIN EFFECT FOR MODALITY FOR TRANSFER CRITERION FOR HIGH READINESS CHILDREN

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability Less Than
Modality	150.521	1	150.521	5.49	.05
Error Term	2195.157	80	27.439		
Total	2345.678	81			

TABLE 11

MEANS AND STANDARD DEVIATIONS - COLLAPSED LEVELS OF MODALITY BY LOW READINESS FOR TRAINING AND TRANSFER CRITERIA

Modality by Low Readiness

	Training Criterion		Transfer Criterion	
	Means	S.D.	Means	S.D.
Visual & Visual-Verbal	7.2876	.9536	10.5417	5.9781
Haptic & Visual-Haptic	7.1521	.7179	8.7917	5.0128

TABLE 12

ANALYSIS OF VARIANCE SUMMARY TABLE FOR EFFECTS TESTED AGAINST THE INITIAL ANALYSIS TO OBTAIN A SIMPLE MAIN EFFECT FOR MODALITY FOR TRAINING CRITERION FOR LOW READINESS CHILDREN

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability Less Than
Modality	.220	1	.220	.406	n.s.
Error Term	43.366	80	.542		
Total	43.586	81			

TABLE 13

ANALYSIS OF VARIANCE SUMMARY TABLE FOR EFFECTS TESTED AGAINST THE INITIAL ANALYSIS TO OBTAIN A SIMPLE MAIN EFFECT FOR MODALITY FOR TRANSFER CRITERION FOR LOW READINESS CHILDREN

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability Less Than
Modality	36.750	1	36.750	1.40	n.s.
Error Term	2195.157	80	27.439		
Total	2231.907	81			